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APMAJ is indexed in Ebscohost and Cabell's Directories



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ASIA-PACIFIC MANAGEMENT ACCOUNTING *JOURNAL*

Volume 3 Issue 1
December 2008



JUST-IN-TIME MANUFACTURING AND PURCHASING PRACTICES AND BUSINESS PERFORMANCE: AN EXPLORATORY STUDY

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Abstract

In today's challenging and turbulent competitive markets, companies need to constantly review their strategies in order to survive and sustain their market positions. One of the strategies frequently adopted by companies to improve manufacturing performance is Just-in-time purchasing and manufacturing practices. Use of JIT enables them to be more efficient, effective and more responsive to customer needs as JIT is based on the philosophy of demand pull and lean manufacturing. This study investigates the relationship between the level of just-in-time (JIT) purchasing and manufacturing practices and performance. It employed a self-administered questionnaire survey to collect data from Malaysian manufacturing companies. The survey results provide empirical evidence that the level of JIT practices was positively related to perceived business performance. The findings reveal that the level of JIT practices were positively related to both perceived financial and non financial performance. The results suggest that companies which implement some aspects of JIT manufacturing and purchasing practices could achieve better financial and non-financial business performance.

Keywords: just-in-time systems (JIT), demand pull, lean manufacturing, perceived business performance

Introduction

Over the last two decades, advancements in information and manufacturing technologies have drastically changed the global competitive environment. To meet the changing demands in this dynamic business environment and to sustain and improve their competitive position and performance, companies are compelled to constantly reevaluate their strategies and devise plans for continuous improvement in their operations. One of the strategies to improve manufacturing performance is adoption of world-class, lean and integrated manufacturing strategies such as just-in-time (JIT) system (Fullerton & McWatters, 2002).

The focus of JIT is cost reduction and excellence through continuous improvements in the business process by redefining the structural and procedural activities performed within an organization (Fullerton & McWatters, 2002). Two main components of the JIT system are JIT manufacturing and JIT purchasing. JIT manufacturing is based on the demand pull and lean manufacturing philosophy which prescribes that companies should only produce products when there is demand for them and there should be continuous efforts for improvement in the manufacturing process. To achieve this, constant evaluation of changes in quality, setup times, defects, rework, and throughput time is imperative. JIT purchasing plays a crucial role to ensure inventories are delivered by reliable suppliers on time for the manufacturing process and inventories held on hand are at a minimum level. These initiatives should then lead to improvement in company's manufacturing performance and improved financial and non-financial business performance. JIT allows companies to reduce costs, meet customer's demands, stay ahead of competitors and minimise slack resources which are critical for survival in the increasingly competitive market (Cobb, 1993).

Given the crucial role of JIT in determining companies' performance, it would be interesting to examine the extent of JIT implementation among Malaysian manufacturing companies. So far, there has been very limited empirical research on JIT system done in Malaysia. The purpose of this research was to examine the extent of JIT practices among Malaysian manufacturing companies and to evaluate empirically the relationship between JIT practices and performance. As there has been very limited empirical evidence on JIT in Malaysia, the findings of this study may improve our understanding of JIT practices among manufacturing companies in Malaysia. In addition, this study could shed valuable insights into the relationship between JIT practices and performance which could assist companies to access whether JIT companies have a competitive edge to compete in today's intense competitive environment.

The remaining parts of this paper are organised as follows. Prior literature related to JIT and organizational performance and the development of the research hypotheses will be discussed in Section 2. The discussion on the research method and the findings of the study are presented in Sections 3 and 4, respectively. The final section summarizes the findings of study, and identifies limitations and further research directions.

Literature Review and Hypotheses Development

JIT Defined

Although there are differing views on the definition of JIT, JIT can be generally defined as a manufacturing programme with the primary goal of continuous

improvement in productivity and reduction and ultimately elimination of all forms of waste through JIT production and employee involvement (Cua *et al.*, 2001; Fullerton & McWatters, 2001; Lawrence & Hottensein, 1995). JIT philosophy was developed in Japan by Toyota Motor Company with the aims of continuously eliminating waste and improving productivity (Ansari and Modarress, 1990). The essence of JIT is elimination of waste through elimination of non-value added activities in purchasing, manufacturing, distribution, and manufacturing support activities of the manufacturing process.

According to Cobb (1991), there are three main elements of JIT philosophy: quality, employee involvement and production flow. Similarly, Golhar and Stamm (1991) suggested four basic tenets of a JIT management philosophy are elimination of waste, employee involvement, supplier participation and total quality control.

Hence, to meet the objective of continuous quality improvement, companies must strive for zero defects through the whole value chain including product design, process design, manufacturing process as well as supplier quality. Meeting these objectives requires employee involvement and commitment. By emphasising quality, companies should be able to achieve reduction in scrap and rework and improved communication among departments and employees (Fullerton & McWatters, 2001). To achieve these results, companies need to ensure certain criteria are fulfilled, for example, steady production flow of small lot size, uniform factory load, efficient plant layout, short set up time, machine cells, pull manufacturing system and JIT purchasing.

JIT Manufacturing

JIT manufacturing is a demand-pull system where products are produced when orders are received from customers and only in the quantities demanded by the customers. JIT manufacturing is defined as a repetitive production system in which processing and movement of material and goods occur just as they are needed, usually in small batches (Stevenson, 1996). This manufacturing system includes practices of preventive maintenance, cellular manufacturing, continuous flow, smaller lot sizes and *kanban* (Foster & Hongren, 1987; Fullerton & McWatters, 2002). Thus, manufacturing plants have to be reorganized so that raw materials and purchased parts are delivered to the plant right before they are entered into the production process.

The JIT approach to manufacturing must consist of the following building blocks: company-wide commitment, proper materials at the right time, supplier relationships, long term contract, quality and personnel (Ansari and Modarress, 1990). Top management support and commitment from all levels of staff are among the most important factors that ensure JIT success through adequate

financial commitment and proper planning before implementation of a JIT manufacturing system (Shannon, 1993).

JIT Purchasing

JIT purchasing system must be in place to support the JIT manufacturing system. In this system, materials are purchased in small quantities from a few reliable suppliers and delivered just before they are needed for production. In an ideal situation, JIT companies should not hold any inventory on hand as holding inventories is considered as a non-value added activity which must be eliminated. By reducing the number of suppliers and improving relationships with these valued partners, JIT companies will benefit from costs and time saving. By ordering small batches which are consumed almost as soon as they arrive, an organization can benefit from space saving resulting from holding much less inventory as well drastic reduction in the costs associated with holding large amounts of inventory, which are in most cases higher than the freight costs and smaller discounts associated with the smaller lot size purchases. These cost savings can be then allocated to alternative uses to improve the overall success of the organization (Ptak, 1997).

JIT and Business Performance

Successful application of the JIT philosophy of cost reduction arguably lead to improvements in both financial and non-financial performance such as lower production costs, higher and faster throughput, improved product quality and on-time delivery of products, which should eventually result in improved profitability (Fullerton *et al.*, 2003). However, it has also been argued that JIT adoption might lead to improved operations but does not necessarily always result in higher profitability (Johnson and Kaplan, 1989) particularly over a short-term period. Cooper (1995) argues that companies should not expect JIT implementation to result in financial benefits over a short-term period but they could instead learn from Japanese counterparts who emphasize stability, long-term reliability, and growth. Comparing Japanese and US transplant manufacturing companies, Nakamura *et al.* (1998) show that the Japanese companies' short-term profits were consistently lower. Consistent with this view, Johnson and Bruns (2000) reveal that it is Toyota's manufacturing strategies which promote growth and stability over the long run and not the achievement of short-run financial targets that contribute to its stable performance.

It has been argued that focussing on financial performance alone is not sufficient for companies to survive and excel in today's market. Kaplan (1984) proposed that non-financial measures of manufacturing performance such as quality, inventory, productivity, innovation, and workforce must also be considered.

Manufacturing companies must be totally committed to quality; that is, each product must be manufactured strictly according to specifications. It has been argued that an exclusive reliance on financial measures in a management system is insufficient, and companies should also focus on non-financial performance indicators for long-term growth and sustainability (Kaplan and Norton, 1992). A performance measurement system based solely on financial reporting indicators has limitations because it focuses on past performance and takes a short-term view of strategy. Exclusive reliance on these indicators could lead managers to focus on short-term performance at the expense of the opportunity to evaluate and develop strategies for long-term value creation. The Balance Scorecard approach maintains measures of financial performance, but supplements these with measures of the lead indicators or key success factors of future financial performance.

Previous studies that examined the direct relationship between JIT implementation and financial performance show mixed results (Balakrishnan *et al.*, 1996; Huson and Nanda, 1995; Inman and Mehra, 1993; Kinney and Wempel, 2002). Inman and Mehra (1993) reported a significant correlation between self-reported improvement in performance and the adoption of JIT practices. On the other hand, Balakrishnan *et al.* (1996) found that there were no differences in return on assets (ROA) among JIT and non-JIT companies. However, when the sample was stratified as high or low customer concentration and different cost structures, JIT companies with low customer concentrations showed significantly higher ROA than non-JIT companies. Extending the study by Balakrishnan *et al.*, Kinney and Wempe (2002) used a similar matched-pair research design to investigate the profitability of JIT and non-JIT companies. Inconsistent with the earlier study, their results indicate that the ROA of the JIT companies fell significantly less compared to the non-JIT companies when tested after three post-JIT adoption years.

A more recent study by Fullerton *et al.* (2003) provides empirical support for the relationship between the degree of JIT practices used and profitability. In this study, JIT implementation was measured using an instrument comprising three dimensions: JIT manufacturing, quality and unique JIT. In addition, three separate measures of profitability were used: return on sales (ROS), ROA and cash flow margin (CFL). They found positive significant relationships between JIT manufacturing practices and profitability supporting the premise that companies that implement higher degrees of JIT manufacturing practices should perform better than those who do not. However, contrary to expectation, the degree of JIT quality practices was inversely and significantly related to company profitability. They argue that these results are “not conclusive since they imply either that the degree of implementation of JIT quality indicators reduces profitability, or companies with low profitability recognize their strategic disadvantage and increase

their focus on quality improvement by implementing JIT quality processes.” (Fullerton et al. 2003, p.400). On the other hand, JIT unique measure shows no significant relationship with profitability. The earlier studies mentioned above produce inconsistent and inconclusive evidence on the nature of the relationship between JIT practices and profitability which warrants further investigation. Thus this study aims to obtain further evidence on the nature of the relationship between JIT practices and performance.

Research Model and Hypotheses

Based on the foregoing discussion, it can be argued that implementation of JIT practices could lead to improvement in business performance. Thus, the following research model and hypotheses are proposed:-

$$Y = b_0 + b_1 X_1 + e$$

Where Y = business performance; X_1 = level of JIT practices

- H_1 = There is a positive relationship between the level of JIT practices and business performance.
- H_{1a} = There is a positive relationship between the level of JIT practices and financial business performance.
- H_{1b} = There is a positive relationship between the level of JIT practices and non-financial business performance.

Research Method

Survey and Sample Design

The research was undertaken using a survey design, where primary data were obtained from companies operating in the Malaysian manufacturing sector. To test the research hypotheses, a survey questionnaire was designed to collect specific information about the manufacturing operations, JIT practices, perceived company performance and the characteristics of the respondents and the sample companies. The survey instrument was subjected to a limited pre-test to check for relevance, readability, completeness and clarity. Feedback was sought from several academicians and managers of five manufacturing companies who are familiar with JIT practices. Relevant and appropriate changes were made accordingly after taking into account the comments and suggestions from the respondents of the pre-test.

The sample comprised manufacturing companies listed in the 2005 Federation of Malaysian Manufacturers (FMM) Directory. Due to time and cost constraints¹, a total of 150 manufacturing companies in Klang Valley and Northern Region of

Peninsular Malaysia was conveniently selected. Questionnaires were distributed through postal mail and email and they were addressed to the finance directors or controllers of the companies who were assumed to possess the expert knowledge related to JIT and performance of their companies. A self-addressed envelope was enclosed with the questionnaire to enable the respondents to return the questionnaire. Follow-up telephone calls were made to ensure that the companies received the questionnaires.

Measures of JIT Practices and Performance

The current study focuses on two major aspects of JIT: manufacturing and purchasing. In this study, JIT practices focused on JIT purchasing and manufacturing practices and it was measured as the extent to which selected JIT manufacturing and purchasing practices were used, similar to the approach used in prior research (e.g. Banker, 1993; Banker; Potter and Schroeder, 1993b; Flynn; Sakakibara and Schroeder, 1995) which measured JIT practices levels based on a representative set of JIT manufacturing practices.

In this study, JIT was not measured as a formal program because the study did not only focus on JIT adopters. The respondents were not specifically asked whether JIT was used in a formal management as it was conjectured that many companies may not have JIT as a formal programme, but may use certain practices similar to the JIT practices. In addition, this allowed a bigger number of companies to participate in the survey as it was conjectured that only a small number of companies in Malaysia had implemented a formal JIT programme in their organisations.

Review of the JIT literature reveals that there are several approaches adopted by researchers in defining JIT implementation. For example, Fullerton *et al.* (2001) measured JIT variable comprising three main components: JIT manufacturing, JIT quality and JIT unique practices. Flynn *et al.* (1995), on the other hand, used JIT unique management practices which consisted of Kanban, lot size reduction practices, setup time reduction practices and JIT scheduling in their study. In this study, six measurable manufacturing practices that reflected JIT purchasing and manufacturing practices were selected to represent JIT implementation. JIT practices were measured using a six-item instrument to measure the extent of JIT practices adopted by the sample companies using a five-point Likert scale ranging from 1 (least extent) to 5 (greatest extent). Although not all inclusive, these six practices were: sampling check, supplier access to production schedule, manufacture after receiving order, use of single cell production, quality checks on raw material, and goods delivery based on the company's production schedule. These measures were selected because they represent the common JIT practices used in companies and thus could be considered as a surrogate measure for JIT

practices. This approach was considered to be more appropriate for data collection purposes as some companies may be using some elements of JIT even though they do not have a formal JIT programme.

This study used the definition of business performance proposed by Mia and Clarke (1999); specifically, “the extent to which the unit had been successful in achieving its planned target(s), such as achievement of planned productivity, costs, quality, delivery schedule, sales volume, market share, and level of profit” (p. 151). They argue that this broad approach to performance assessment has an advantage over the ‘return on investment’ (ROI) or input output ratio method of performance measure because it incorporates all aspects (qualitative and quantitative, financial and non-financial) of business performance. In contrast, the conventional performance evaluation methods such as ROI and input/output ratio consider only the quantitative aspects.

Self-reported measures of performance were used in other studies such as Govindarajan (1988), Govindarajan and Fisher (1990), and Chenhall and Langfield-Smith (1998), in which respondents were asked to assess their business’s performance relative to competitors’ over the last three years. In these studies asked the respondents were asked to rate their companies’ achievement for 10 performance indicators on a scale of 1 (Very poor) to 7 (Very Excellent). The indicators were productivity, costs, quality, delivery, service, sales volume, market share, profit, new product introduction and overall performance.

The self-reported business performance measure also used by (Mia and Clarke, 1999 and Khandwalla, 1972, 1977) was used to measure business performance in this study. Respondents were asked to indicate their company’s actual achievement compared to their target performance in terms of financial and non-financial performance indicators such as productivity, costs, quality, delivery schedule, sales volume, market share, and level of profit using a five-point Likert scale, 1 representing ‘poor performance’ and 5 representing ‘excellent performance’. In this study used an 8-item instrument comprising the following items: profit, cost savings, on-time delivery, improvement in manufacturing time, product quality, space saving, improvement in purchasing lead time and product innovation.

Results and Discussion

The section contains the findings of this study. It starts with a discussion on the profile of the sample companies, followed by the profile of the respondents, descriptive statistics of the main variables and, lastly, the statistical associations between JIT practices and performance.

Profile of Respondents and Companies

Out of 150 questionnaires sent out, a total of 87 questionnaires was received but 11 questionnaires were incomplete and thus were excluded from the final analysis. A total of 76 questionnaires was used for the final analysis giving a response rate of 50.6%. Table 1 shows the profile of the respondents. In terms of age, the largest group of respondents belonged to the 31 to 40 year old age group (44.7%), followed by the 21 to 30 age group (42%), and 11.8% of the respondents from the 41 to 50 year old group. There were 35 (46.1%) male respondents and 41 (53.9%) female respondents.

With regards to educational background, the majority of the respondents (80.3%) had a degree as shown in Table 1. More than 50% of them had served their companies for more than 5 years. A majority of the respondents were in the middle management group, as 88.2% of them were managers and executives and therefore can be assumed to be the appropriate respondents for the study as they possessed adequate knowledge related to the management practices within their organizations.

Table 1: Profile of Respondents

Backgrounds	Categories	Frequency	Percentage
Age	21 to 30 years old	32	42%
	31 to 40 years old	34	44.7%
	41 to 50 years old	9	11.8%
	above 51 years old	1	1.3 %
Gender	Male	35	46.1%
	Female	41	53.9%
Education Background	Diploma and Advance Diploma	2	2.6%
	Degree	61	80.3%
	Master	9	11.8%
	Professional Course	4	5.3%
Length of service	0 to 2 years	10	13.2%
	above 2 to 5 years	26	34.2%
	above 5 to 10 years	18	23.7%
	more than 10 years	22	28.9%
Occupation Level	Director	1	1.3%
	Engineers	28	10.5%
	Managers	29	38.2%
	Executives	38	50.0%

Table 2 shows that the sample companies were from the various industries. In terms of annual sales, more than half of the companies had less than RM30 million of sales and foreign companies represented almost half (42%) of the

respondents. Most of the companies (51.3%) had an average of fewer than 500 full time staff. Almost 60% of the sample companies were in the small and medium size category with shareholders' equity of less than RM25 million.

Table 2: Profile of Sample Companies

Backgrounds	Categories	Frequency	Percentage
Types of Industry	Foods & Beverages	9	11.8%
	Textiles & Clothing	9	11.8%
	Wood products	4	5.3%
	Chemical	8	10.5%
	Metal products	2	7.9%
	Rubber products	10	2.6%
	Electrical & electronics	3	13.2%
	Plastic products	25	3.9%
	Others		32.9%
Annual Sales	Under RM 5 million	4	5.3%
	RM 5 to under RM 20 million	27	35.5%
	RM 20 to under RM 30 million	17	22.4%
	RM 30 to under RM 50 million	7	9.2%
	above RM 50 million		27.6%
Ownership	Local	29	38.5%
	Foreign	32	42.1%
	Joint Venture	15	19.7%
Total Shareholders Funds	Less than RM 2.5 million	8	10.5%
	Between RM 2.5 – RM 25 million	36	47.4%
	Between RM 26 – RM 50 million	22	28.9%
	Above RM 50 million	10	13.2 %
Full Time Employees	Below 500	39	51.3%
	501 – 1000	25	32.9%
	1001 – 1500	5	6.6%
	Above 2500	7	9.2%

Descriptive Analysis and Reliability

Tables 3 and 4, respectively show the descriptive statistics for JIT practices and business performance. Reliability of the measures was checked using Cronbach alpha reliability of coefficient based on Nunnally's (1978). The independent variable (JIT practices) was represented by 6 items and the value of Cronbach alpha was 0.612. The dependent variable (performance) was measured by eight items and the Cronbach alpha was 0.628. As the alpha value was above the average value of 0.600, the internal consistency of the reliability of these measures was reasonably good.

Eight indicators were used to measure JIT manufacturing and purchasing practices: quality checks on raw material by suppliers (inventory inspection by supplier), suppliers having access to the production schedule that allow them to deliver goods just in time for production (supplier access to production schedule), delivery of goods based on company's production schedule (delivery based on production's schedule), use of single production cell (single cell production), product quality check (quality sample check) and manufacture after receiving order (demand pull manufacturing). The overall mean was 3.42 suggesting a moderate level of JIT practices for the whole sample. The most common JIT practices among the sample companies was 'delivery of goods based company's production schedule' as indicated by the mean value (3.75) while the most infrequently used JIT practices was 'supplier access to production schedule' (mean = 2.66).

Table 3: Descriptive Statistics for JIT Practices Variable

Item	Mean	Standard Deviation	Actual Range	
			Min	Max
Supplier access to production schedule	2.66	1.14	1	5
Inventory inspection by supplier	3.61	1.06	1	5
Supplier delivery based production's schedule	3.75	1.01	1	5
Single cell production	3.36	1.26	1	5
Demand pull manufacturing	3.63	1.02	1	5
Quality sample check	3.63	0.85	2	5
Overall	3.42	0.65	1.43	5

Cronbach alpha: 0.612

Table 4 displays the descriptive statistics for the self-reported or perceived business performance. The respondents were asked to rate their company's performance within the last three years by comparing targeted and actual performance with respect to eight performance indicators comprising both financial and non-financial indicators. Table 4 indicates that the mean values of all indicators, except for innovation introduced, were higher than 3.0 suggesting that on average, most of the respondents felt that their companies were performing better than targeted, especially with respect to factory or space saving (mean = 3.42) and cost savings (mean = 3.33). The companies also perceived that they were performing better than targeted in terms of on-time delivery (mean = 3.28) and product quality (mean = 3.28).

Table 4: Descriptive Statistics for Business Performance

Criteria	Mean	Standard Deviation	Actual Range	
			Mini	Max
Overall Performance	3.20	0.43	1.63	4.13
Financial:				
Profit before Tax	3.14	0.88	1	5
Cost Savings	3.33	0.76	1	4
Non Financial:				
On-time delivery	3.28	0.87	1	5
Manufacturing time	3.18	0.62	2	4
Product quality	3.28	0.76	2	4
Space saving	3.42	0.90	1	5
Reduce purchasing time	3.14	0.91	1	5
Innovation	2.79	0.85	1	4
Cronbach alpha: 0.628				

Hypotheses Testing

A Pearson correlation analysis was carried out to obtain some indications of whether JIT and performance were correlated. The results of the analysis are shown in Table 5.

Table 5: Correlation between JIT practices and Performance

	JIT Implementation	Overall Performance	Financial Performance	Non-financial Performance
JIT practices	1			
Overall	0.482	1		
Performance	(p = 0.000)			
Financial	0.447	0.973	1	
performance	(p = 0.000)	(p = 0.000)		
Non-financial	0.312	0.482	0.266	1
performance	(p = 0.006)	(p = 0.000)	(p = 0.020)	

The results indicate the presence of significant correlations between JIT practices and overall performance ($r = 0.482$) at the significance level of 0.01. The correlation between financial performance (profit and cost saving) and JIT practices was also significant ($r = 0.447$) at the significance level of 0.01. Similarly, JIT practices were significantly correlated with non-financial performance ($r = 0.312$) at the significance level of 0.01. These results suggest the two variables are significantly correlated, thus providing initial support for further analysis to test the hypotheses.

To test the research hypotheses, regression analyses were carried out to examine the relationship between JIT practices and performance. A linear regression was

conducted to test the relationship between the independent variable, overall level of JIT practices, and the dependent variable, business performance (equation 1). Similar procedures were repeated using financial performance (equation 2) and non-financial performance (equation 3) as the dependent variables. The following are the related regression equations:

$$\text{Equation 1: } Y_1 = b_0 + b_1X_1 + e,$$

Where Y_1 = business performance; X_1 = level of JIT practices;

$$\text{Equation 2: } Y_2 = b_0 + b_1X_1 + e,$$

Where Y_2 = financial performance; X_1 = level of JIT practices;

$$\text{Equation 3: } Y_3 = b_0 + b_1X_1 + e,$$

Where Y_3 = non-financial performance; X_1 = level of JIT practices.

The linear regression results, shown by Table 6, indicate a significant and positive relationship exists between JIT practices and overall performance ($\beta = 4.88$, $p \leq 0.01$), thus lending support to Hypothesis 1. Similarly, JIT practices are positively and significantly related to financial ($\beta = 3.32$, $p \leq 0.01$) as well as non-financial performance ($\beta = 4.36$, $p \leq 0.01$). Hence, sub-hypotheses H_{1a} and H_{1b} are also supported. The results as indicated by the adjusted R^2 suggest that the level of JIT practices accounted for almost 23%, 10% and 18%, respectively, of the changes in overall, financial and non-financial performance.

The regression results provide support for our predictions that usage of JIT practices should lead to better performance. This is consistent with previous research finding which suggest that JIT's philosophy of waste elimination and continuous improvement leads to more efficient operations which will result in financial performance improvement (Womack and Jones, 1996; Fullerton *et al.*, 2003).

Table 6: Summary of Results of Regression Analyses

Independent Variable	Dependent Variable: Performance		
	Overall Performance	Financial Performance	Non-financial Performance
JIT practices	0.488***	0.332***	0.438***
R^2	0.238	0.110	0.192
Adj. R^2	0.227	0.098	0.181
F	23.079***	9.159***	17.585***

*** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.10$

To explore further the roles of each JIT practices variable in predicting the performance, multiple regression analyses were carried out. Three separate multiple regression analyses were carried out using JIT practices variables as the independent variables while the dependent variables were overall business performance (equation 1), financial performance (equation 2) and non-financial performance (equation 3), respectively. The following are the related regression equations:

$$\text{Equation 1: } Y_1 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e$$

$$\text{Equation 2: } Y_2 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e$$

$$\text{Equation 3: } Y_3 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e$$

Where:

Y_1 = business performance;

Y_2 = financial performance;

Y_3 = non-financial performance;

X_1 = Quality sample check;

X_2 = Manufacture after receive order,

X_3 = Use single cell production;

X_4 = Inventory inspection by suppliers;

X_5 = Deliver goods based on company's production schedule;

X_6 = Supplier access to production schedule.

The results shown in Table 7 indicate the overall business performance is significantly related to 3 variables (quality sampling check, supplier access to production schedule and delivery of goods based on the company's production schedule) at the significance level of 0.05. With regards to financial performance, only one factor, 'supplier access to production schedule' was significantly related at the significance level of 0.001. On the other hand, non-financial performance was related to three factors at the significance level of 0.05: quality sampling check, inventory inspection by suppliers, and supplier delivery of goods based on the company's production schedule. The adjusted R^2 for the equations 1, 2, and 3, respectively, indicates that 29%, 14% and 28% of the variations in the dependent variables; overall, financial and non-financial performance, are explained by the variations in the independent variables, JIT practices.

The multiple regression results offer additional insights into the predictors of the overall performance, as well as financial and non-financial performance. The results suggest that performance is positively affected mainly by four JIT practices:

quality sample check, inspection of inventory by suppliers before delivery, delivery based on company's production schedule and supplier access to production schedule. These results suggest that companies implementing these JIT practices achieve better financial and non-financial performance which is consistent with the findings of other studies. For example, studies have found companies that implemented more of JIT manufacturing practices outperformed those which did not (Fullerton *et al*, 2003) and JIT implementation improves performance through lower inventory levels, reduced quality costs, and greater customer responsiveness (Fullerton and McWatters, 2001).

Table 7: Results of Multiple Regression Analyses

Independent Variable: JIT practices	Dependent Variable: Performance		
	Overall Performance	Financial Performance	Non-financial Performance
Quality sample check	0.311**	0.196	0.287**
Manufacture after receive order	0.000	0.042	-0.020
Use single cell production	-0.128	-0.148	-0.86
Inventory inspection by suppliers	0.203*	-0.048	0.270**
Deliver goods based on company's production schedule	0.297**	0.187	0.274**
Supplier access to production schedule	0.250**	0.486***	0.100
R ²	0.343	0.207	0.333
Adj. R ²	0.286	0.138	0.275
F	6.004***	3.008**	5.734***

***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.10

Conclusions

JIT's philosophy based on the concept of waste elimination and continuous improvement should lead to more efficient operations which will then result in improved business performance. The main purpose of this study was to determine whether JIT practices were related to business performance. It was hypothesized that JIT practices were positively related to overall, financial and non-financial performance. The results of the survey on selected Malaysian manufacturing companies reveal a moderate level of JIT practices among the sample companies. In terms of level of performance, generally, the sample companies reported above-average performance in all performance indicators, except for innovation.

Overall, the results of the correlation and regression analyses provide support for the hypotheses, suggesting JIT practices are one of the predictors of performance in manufacturing companies in Malaysia. The results are consistent with the findings of other empirical studies for example Inman and Mehra (1993) who

reported a significant correlation between self-reported improvement in performance and adoption of JIT practices. However, the results of studies which define financial performance as reported profitability or ROA show mixed results (Balakrishnan *et al.*, 1996; Fullerton *et al.*, 2003; Huson and Nanda, 1995; Inman and Mehra, 1993; Kinney and Wempel, 2002). The inconsistent findings on the nature of the relationship between JIT practices and profitability suggest further investigation in this area of research is much warranted.

The findings of this study contribute to the current body of literature related to JIT and its impact on performance especially in the context of Malaysian manufacturing firms. Manufacturing companies would benefit from JIT implementation as the JIT philosophy of continuous improvement and elimination of waste would lead to more efficient and lean operations and improved non-financial and financial performance.

The results of the study, however, are subject to the several limitations. First, the study is associated with the usual limitations of cross-sectional survey research, namely data collected at a single point of time. Second, this study covers only manufacturing companies and used a non-random sample. It is possible the effects of JIT practices on performance may be different for other sectors, such as services sector. Third, a majority of the respondents in the survey were middle-level managers and not the senior or top-level managers as initially planned. Thus it may be possible that the respondents might have been unfamiliar with the terms used in the questionnaire to describe JIT practices and performance and also there may be differences in perceptions between the two groups of managers. In addition, the sample size in this study was relatively small which limited the use of more powerful statistical tests as well as generalisability of the research results. Fourth, the survey instruments used to measure JIT practices and performance developed based on the relevant literature, might have been completely indicative of local company practices. Lastly, as indicated by the R^2 and adjusted R^2 in the regression models, there may be other important predicting variables that could be added to improve its explanatory power.

In view of the limitations above, future research could investigate further into the nature and degree of JIT practices through the use of a bigger sample and inclusion of other sectors such as the service industry. The instruments for the JIT practices and performance could be further improved.

Note

- ¹ This project was part of the MBA course requirements and was carried over a period of 3 months.

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